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PAECILOMYCES LILACINUS, A FUNGUS THAT PARASITIZES NEMATODE EGGS[1]

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INTRODUCTION: *Paecilomyces lilacinus* (Thom.) Samson principally infects and assimilates eggs of root-knot (*Meloidogyne* spp.) and cyst nematodes (*Globodera* spp., and *Heterodera* spp.). The fungus has been the subject of considerable biological control research following its discovery as a biological control agent in 1979 (10). *Paecilomyces lilacinus* has been considered to have "the gratest potential for application as a biocontrol agent in sub-tropical and tropical agricultural soils" (12).

GEOGRAPHIC DISTRIBUTION: *P. lilacinus* has an almost worldwide distribution occuring most frequently in warmer climates (7). To enhance its distribution, cultures of the fungus were sent to research workers in 46 countries through the "International *Meloidogyne* Project" (9).

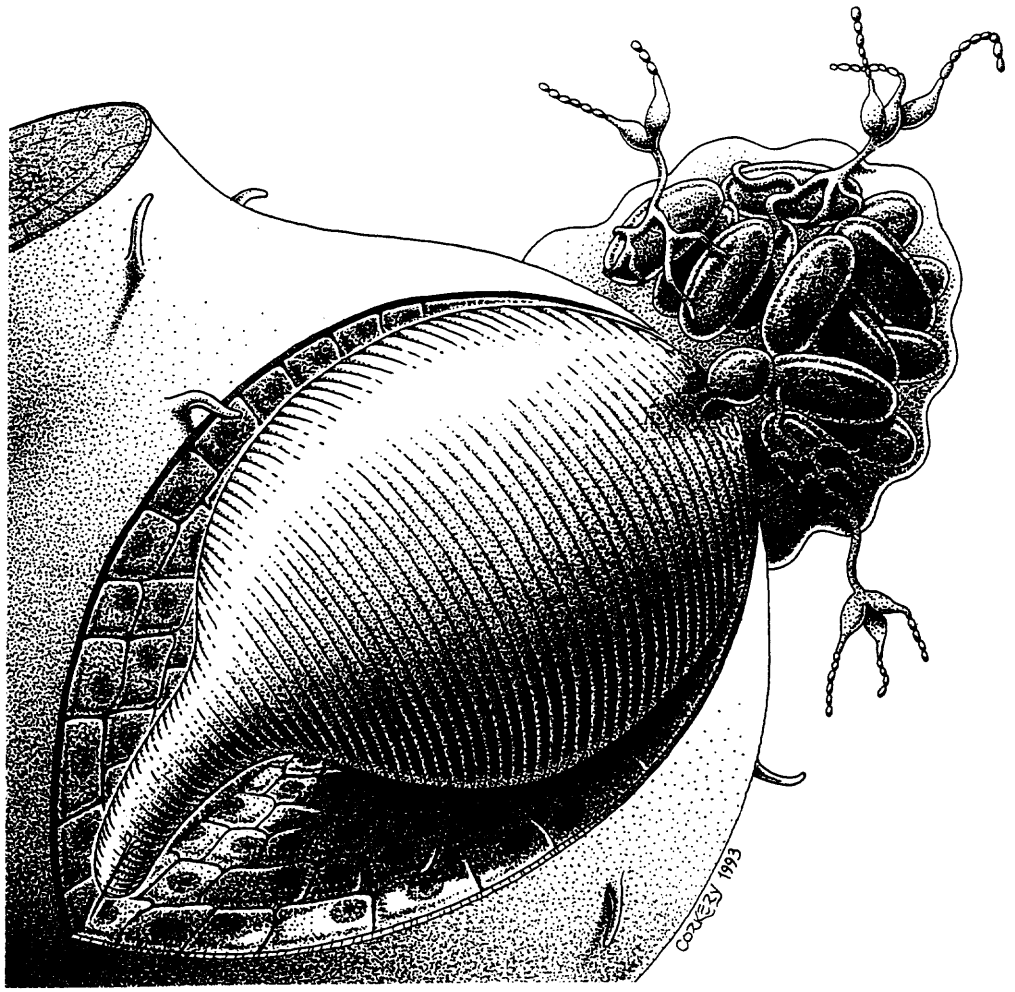

Fig. 1. A root-knot nematode (*Meloidogyne* sp.) female with its egg mass infected with *Paecilomyces lilacinus*.

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CHARACTERIZATION OF *P. LILACINUS:* The fungus is a lilac to purple-colored soil hyphomycete, producing smooth to rough conidia endogenously from small groups of unclumped phialides borne on conidiophores (Figs. 1-2). Vegetative hyphae are branched and septate.

HABITAT: *P. lilacinus* occurs naturally in soil, in egg clusters contained in the gelatinous egg mass of root-knot nematodes, and in cysts of *Globodera* spp. and *Heterodera* spp.

INFECTION: Vegetative hyphae enter the gelatinous matrix of root-knot nematode, or grow into the vulva or open cyst neck of cyst nematodes. Once inside, hyphae form branches and grow across egg shell surfaces. Hyphal tips swell, forming an appressorium on the egg surface. A penetration peg forms below the appressorium and grows into the egg shell. Penetrated eggs swell and buckle. As penetration continues, the vitelline layer of the egg splits into three bands, numerous vacuoles appear, and the lipid layer almost disappears (11). Hyphae fill the egg, then emerge to the egg surface producing first vegetative growth and then conidiophores and conidia. After five days, most of the eggs in the mass are infected. Juveniles in eggs may become infected when such eggs are invaded by the fungus. Adult females become infected when hyphae enter the vulva or anus (10).

DAMAGE: Egg hatch is reduced, and numbers of root galls and egg masses may be reduced or suppressed in some instances. Giant cell formation in host plant tissue is inhibited (2).

NEMATODES WHOSE OVA ARE PARASITIZED BY *PAECILOMYCES LILACINUS:* *Globodera pallida* (Stone, 1973) Behrens, 1975; *G. rostochiensis* (Wollenweber, 1923) Behrens, 1955; *Heterodera avenae* Wollenweber, 1924; *Heterodera glycines* Ichinoe, 1952; *Meloidogyne acrita* (Chitwood, 1949) Esser, Perry & Taylor, 1976; *M. arenaria* (Neal, 1889) Chitwood, 1949; *M. incognita* (Kofoid & White, 1919) Chitwood, 1949; *M. javanica* (Traub, 1885) Chitwood, 1949; *Nacobbus aberrans* (Thorne, 1935) Thorne & Allen, 1944; *Rotylenchulus reniformis* Linford & Oliviera, 1940; *Thecavermiculatus andinus* (de Guiran, 1967) Tarjan, 1973; and *Tylenchulus semipenetrans* Cobb, 1913. *P. lilacinus* has also infected the vertebrate nematode parasite *Ascaris lumbricoides* L., 1758 (5) and some insect species (3,4,7).

MEDICAL WARNING: *P. lilacinus* can cause opportunistic systemic fungal diseases of humans and has been implicated in eye (1), lung (7), skin (14,15) and heart infections (7). As a consequence, one must take extreme care in working with this fungus.

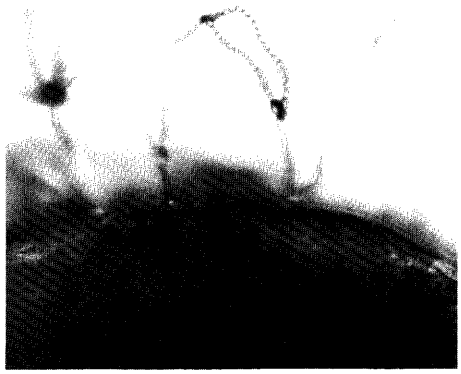

Fig. 2. *Paecilomyces lilacinus* conidiophores emerging from a root-knot female nematode.

BIOLOGICAL CONTROL POTENTIAL: *P. lilacinus* has been characterized as aggressive, and Dunn *et al* (7) stated, "The fungal egg parasites, as a group appear to be more promising to investigate as potential biological control agents of nematodes." Research results utilizing this fungus have been contradictory and erratic. In one experiment, the fungus caused a 71% reduction of root galls and a 90% reduction in egg masses on root-knot nematode-infected corn (8). In other experiments, the fungus failed to control root-knot nematode (6, 16). Stirling (14) stated, "Several groups claim to have controlled root-knot and cyst nematodes by introducing *P. lilacinus* into the field but in many instances the published data is insufficient to fully evaluate the experiments." A table is provided to justify this premise. Rodriguez-Kabana *et al.* (13) stated, "...isolates of *P. lilacinus* can differ widely in their ability to establish in soil, and in their capacity to control *M. arenaria*."

In contrast to predatory nematophagous fungi, which possess some mechanism of entrapment (e.g., sticky hyphae or spores, constricting ring traps, or zoospores that swim, attach and infect the prey) *P. lilacinus* lacks a mechanism of aggressive trapping or attachment. Therefore, its potential success as a biological control agent of motile nematodes is very limited. To become infected, its prey must be in direct (facultative) contact with the fungal conidia and remain immobile for a time. The non-aggressive infection mechanism of *P. lilacinus* explains why the parasitic activity of this fungus is restricted to nematode eggs and sedentary stages of phytoparasitic nematode The majority of nematode pests of plants are motile and probably escape infection by this fungus. In most cases, two or more phytoparasitic species of nematodes are feeding on one plant host, so if one species is decreased or eliminated the parasitic attrition continues.

CONCLUSIONS: One must consider *P. lilacinus* to have a very low biological control potential or future for the following reasons:

1) Medical: the fungus could pose a medical hazard to researchers, graduate students and applicators because of its potential mycoses of the skin, lungs, heart and eyes.
2) Erratic results in field trials: isolates of *P. lilacinus* differ widely in virulence and ability to become established in soil (11).
3) The fungus lacks an effective aggressive trapping mechanism which severely limits its potential.

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